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भाग 4 "pD" सुरक्षा टाईप

Indian Standard

ELECTRICAL APPARATUS FOR USE IN THE PRESENCE OF COMBUSTIBLE DUST

PART 4 TYPE OF PROTECTION "pD"

ICS 29.260.20

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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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Electrical Apparatus for Explosive Atmospheres Sectional Committee, ETD 22

NATIONAL FOREWORD

This Indian Standard (Part 4) which is identical with IEC 61241-4 : 2001 'Electrical apparatus for use in the presence of combustible dust — Part 4: Type of protection "pD" ' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Electrical Apparatus for Explosive Atmospheres Sectional Committee and approval of the Electrotechnical Division Council.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker in the International Standard while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, references appear to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards, which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60034-1 : 1996 Rotating electrical machines — Part 1: Rating and performance	IS 325 : 1996 Three-phase induction motors (*first revision*)	Technically Equivalent
IEC 61241 (all parts) Electrical apparatus for use in the presence of combustible dust	IS/IEC 61241 (all parts) Electrical apparatus for use in the presence of combustible dust	do
IEC 61241-1-1 : 1999[1] Electrical apparatus protected by enclosures and surface temperature limitation — Specification for apparatus	IS/IEC 61241-0 : 2004 Electrical apparatus for use in the presence of combustible dust: Part 0 General requirements IS/IEC 61241-1 : 2004 Electrical apparatus for use in the presence of combustible dust: Part 1 Protection by enclosures "tD"	Identical
IEC 61241-1-2 : 1999[2] Electrical apparatus protected by enclosures and surface temperature limitation — Selection, installation and maintenance	IS/IEC 61241-14 : 2004 Electrical apparatus for use in the presence of combustible dust: Part 14 Selection and installation	do
IEC 61241-3 : 1997[3] Classification of areas where combustible dusts are or may be present	IS/IEC 61241-10 : 2004 Electrical apparatus for use in the presence of combustible dust : Part 10 Classification of areas where combustible dusts are or may be present	do

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[1] Superseded by IEC 61241-0 : 2004 and IEC 61241-1 : 2004. Both adopted as identical Indian Standards.

[2] Superseded by IEC 61241-14 : 2004 and adopted as identical Indian Standard.

[3] Superseded by IEC 61241-10 and adopted as identical Indian Standard.

(*Continued on third cover*)

Indian Standard

ELECTRICAL APPARATUS FOR USE IN THE PRESENCE OF COMBUSTIBLE DUST

PART 4 TYPE OF PROTECTION "pD"

1 Scope

This part of IEC 61241 gives requirements on the design, construction, testing and marking of electrical apparatus for use in combustible dust atmospheres in which a protective gas (air or inert gas), maintained at a pressure above that of the external atmosphere, is used to prevent the entry of dust which might otherwise lead to the formation of a combustible mixture within enclosures which do not contain a source of combustible dust.

This standard contains the specific requirements for construction and testing, including protective requirements that apply to electrical apparatus with type of protection pressurization "pD" intended for use in potentially combustible dust atmospheres.

This standard includes the requirements for the construction of the enclosure and its associated components, including, if any, the inlet and outlet ducts for the protective gas, and for the safety provisions and devices necessary to ensure that pressurization is established and maintained for type of protection pressurization "pD".

Requirements for pressurized enclosures with an internal source of dust release are not included in this standard.

This standard does not cover the requirements for pressurized rooms with or without internal sources of dust release.

This standard does not apply to dusts of explosives which do not require atmospheric oxygen for combustion or to pyrophoric substances.

This standard does not cover combined gas and dust hazard. Those requirements are under consideration.

The requirements contained in this standard are supplementary to those in IEC 61241-1-1.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61241. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 61241 are encouraged to investigate the possibility of applying the most recent editions of the normative documents listed below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60034-1:1996, *Rotating electrical machines – Part 1: Rating and performance* [1]

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[1] There exists a consolidated edition 10.2 (1999) that includes edition 10.0 and its amendments.

IEC 61241 (all parts), *Electrical apparatus for use in the presence of combustible dust*

IEC 61241-1-1:1999, *Electrical apparatus for use in the presence of combustible dust – Part 1-1: Electrical apparatus protected by enclosures and surface temperature limitation – Specification for apparatus*

IEC 61241-1-2:1999, *Electrical apparatus for use in the presence of combustible dust – Part 1-2: Electrical apparatus protected by enclosures and surface temperature limitation – Selection, installation and maintenance*

IEC 61241-3:1997, *Electrical apparatus for use in the presence of combustible dust – Part 3: Classification of areas where combustible dusts are or may be present*

3 Definitions

For the purpose of this part of IEC 61241, the definitions from IEC 61241-1-1 and the following apply.

3.1
type of protection "pD"
technique of applying a protective gas to an enclosure in order to prevent the formation of an explosive dust atmosphere inside the enclosure by maintaining an overpressure against the surrounding atmosphere

3.2
overpressure
pressure above ambient pressure within a pressurized enclosure

3.3
pressurization
technique of guarding against the ingress of the external dust atmosphere, which may be explosive, into an enclosure by maintaining a protective gas therein at a pressure above that of the external atmosphere

3.4
protective gas
air or inert gas used for maintaining an overpressure

NOTE For the purpose of this standard inert gas means nitrogen, carbon dioxide, argon or any gas which, when mixed with oxygen in the ratio of 4:1 as found in air, does not make the ignition and combustible properties, such as combustible limits, more onerous.

3.5
enclosure
all the walls which surround the live parts of electrical apparatus including doors, covers, cable entries, rods, spindles and shafts and which ensure the protection of the electrical apparatus

3.6
pressurized enclosure
enclosure in which protective gas is maintained at a pressure greater than that of the external atmosphere

NOTE The pressurized enclosure may or may not also be the enclosure surrounding the live parts and ensuring the protection in other respects of the electrical apparatus.

3.7
static pressurization
maintenance of an overpressure within a pressurized enclosure without the addition of protective gas in a hazardous area

3.8
pressurization with leakage compensation
maintenance of an overpressure within a pressurized enclosure so that, when the outlet apertures – if any – are closed, the supply of protective gas is sufficient to compensate for any leakage from the pressurized enclosure and its ducts

3.9
pressurization with continuous flow of the protective gas
maintenance of an overpressure within a pressurized enclosure with continuous flow of the protective gas through the enclosure

3.10
electrical apparatus
items applied as a whole or in part for the utilization of electrical energy. These include, among others, items for the generation, transmission, distribution, storage, measurement, regulation, conversion, and consumption of electrical energy and items for telecommunications

3.11
ignition-capable apparatus
apparatus which, in normal operation, constitutes a source of ignition for a specified combustible dust atmosphere. This includes electrical apparatus not protected by a type of protection listed in IEC 61241-1-2

3.12
self-revealing fault
fault which would cause a malfunction of the apparatus necessitating correction before proceeding with further operation of the apparatus and which may be indicated, for example, by an audible or visible signal

3.13
opening
aperture, door, window or non-airtight fixed panel

3.14
protective device
device provided to protect a system against conditions which could result in a fire or explosion

3.15
alarm
piece of apparatus that generates a visual or audible signal that is intended to attract attention

3.16
indicator
piece of apparatus that shows flow or pressure and is monitored periodically, consistent with the requirement of the application

3.17
protected apparatus
electrical apparatus internal to the pressurized enclosure

3.18

pressurization system

grouping of components used to pressurize and monitor a pressurized enclosure

3.19

alternate (or auxiliary) source of supply of protective gas

second source of protective gas that may take over in the event of failure of the primary source

3.20

zones

classified areas are divided into zones based upon the frequency and duration of the occurrence of explosive dust/air mixtures. Dust layers should also be taken into consideration [IEC 61241-3, definition 2.10]

3.21

zone 20

area in which combustible dust, as a cloud, is present continuously or frequently, during normal operation, in sufficient quantity to be capable of producing an explosive concentration of combustible dust mixed with air, and/or where layers of dust of uncontrollable and excessive thickness can be formed.

This can be the case inside dust containment areas where dust can form explosive mixtures frequently or for long periods of time. This occurs typically inside equipment
[IEC 61241-3, definition 2.11]

3.22

zone 21

area not classified as zone 20 in which combustible dust, as a cloud, is likely to occur during normal operation, in sufficient quantities to be capable of producing an explosive concentration of combustible dust mixed with air.

This zone can include, among others, areas in the immediate vicinity of powder filling or emptying points and areas where dust layers occur and are likely, in normal operation, to give rise to an explosive concentration of combustible dust mixed with air
[IEC 61241-3, definition 2.12]

3.23

zone 22

areas not classified as zone 21 in which combustible dust clouds may occur infrequently, and persist for only a short period, or in which accumulations or layers of combustible dust may be present under abnormal conditions and give rise to combustible mixtures of dust in air. Where, following an abnormal condition, the removal of dust accumulations or layers cannot be assured, then the area is to be classified zone 21.

This zone can include, among others, areas in the vicinity of equipment containing dust, where dust can escape from leaks and form deposits (such as milling rooms in which dust can escape from the mills and then settle)
IEC 61241-3, definition 2.13]

4 Pressurization principle

Protection by pressurization is a type of protection that relies upon the interior of the enclosure being subjected to a continuous overpressure from a supply of protective gas while electrical equipment within the enclosure is energized.

In designing a pressurization system, the following basic principles apply.

4.1 Protective gas

There is a suitable supply of protective gas capable of maintaining the pressure above a predetermined level except for static pressurization as given in clause 7.

4.2 Automatic disconnection

Pressurization failure automatically disconnects the system from the electricity supply and/or initiates alarms.

4.3 Cleaning

The enclosure is cleaned before the electrical supply can be connected, in order to remove any accumulated combustible dust left in the enclosure, either accidentally following failure of the pressurization system, or following normal shutdown.

4.4 Discharge of protective gas

Preferably, the protective gas may be discharged into a non-hazardous area. In the case of pressurization with continuous flow, and where the protective gas is discharged into the hazardous area, means are to be provided to prevent hot particles or other ignition sources from equipment under normal or fault conditions entering the hazardous area.

5 General constructional requirements

5.1 Electrical performance of apparatus

The electrical performance of apparatus contained within the enclosure shall be such that the apparatus is capable of functioning up to its full rating and recognized overloads, if any, without detriment to the enclosure or rise in surface temperature in excess of the specified limits.

NOTE Safeguarding against potential arcing faults that might lead to the failure of an enclosure should be considered, taking into account fault levels together with protection and safety devices fitted.

5.2 Mechanical strength

The pressurized enclosure ducts, if any, and their connecting parts, shall withstand a pressure equal to 1,5 times the maximum overpressure specified by the manufacturer for normal service with all outlets closed, with a minimum of 200 Pa (2 mbar).

If a pressure can occur in service that can cause a deformation of the enclosure ducts, if any, or connecting parts, a safety device shall be fitted by the manufacturer to limit the maximum internal overpressure to a level below that which could adversely affect the type of protection.

NOTE Equipment with large surface areas, which are subjected to pressures in excess of 1 kPa (for example, sheet metal enclosures), may require approval from the relevant authority responsible for pressure vessel inspection.

5.3 Apertures

5.3.1 In the case of static pressurization, the enclosure shall have one or more apertures. After filling and pressurization, all apertures shall be closed.

5.3.2 In the case of pressurization with leakage compensation, the enclosure shall have one or more inlet apertures.

5.3.3 In the case of pressurization with continuous flow of protective gas, the enclosure shall have one or more inlet apertures and one or more outlet apertures for the connection of the inlet and outlet ducts for the protective gas.

5.4 Electrical connections to enclosures

The entry of electrical conductors shall be by means of a cable gland or conduit directly into the enclosure such that the method of protection is maintained, or by means of a separate terminal box which is protected by one of the types of protection for electrical equipment in combustible dust atmospheres in accordance with IEC 61241-1-2.

5.5 Doors and covers

When it is necessary to delay the opening of an enclosure due to a risk of explosion because of the existence of an external explosive dust atmosphere, and due, for example, to the surface temperature of internal parts of that equipment or to residual charge on components, the doors and covers shall carry a warning giving the delay to be observed after switching off the electrical supply.

Doors and covers which can be opened without the use of tools or keys shall be interlocked with the electrical supply to disconnect all power to the electrical apparatus.

In the case of static pressurization, doors and covers shall only be opened by the use of a tool, and shall carry the following warning:

REMOVE TO A NON-HAZARDOUS AREA BEFORE OPENING

Where doors and covers are provided to permit inspection in service, they shall carry the following or equivalent warning:

DO NOT OPEN WHILE ENERGIZED

except where provision is made for adjustment during operation, in which case the warning shall indicate

SEE INSTRUCTIONS BEFORE OPENING

A suitable number of doors or covers shall be provided for effective cleaning. The number of doors and covers are to be chosen with regard to the design and disposition of the apparatus, particular consideration being given to the needs of subcompartments into which the apparatus might be divided.

6 Temperature limits

The equipment shall be classified in accordance with IEC 61241-1-1. The classification shall be determined by the higher of the following temperatures:

a) the maximum external surface temperature of the enclosure;

b) the maximum surface temperatures of internal parts that are protected by a type of protection in accordance with IEC 61241-1-2 and which remain energized when the supply of protective gas for pressurization is removed or fails, for example electric heaters.

If, during normal service, the temperatures of internal surfaces which may be exposed to an explosive dust atmosphere exceed the maximum values permitted in IEC 61241-1-1 for the temperature class of the equipment, appropriate measures shall be taken to ensure that, if pressurization ceases, any explosive dust atmosphere which may exist is prevented from making contact with that surface before it has cooled below the permitted maximum value. This may be achieved either by design and construction of the joints of the pressurized enclosure and ducts by other means, for example, by bringing alternative (or auxiliary) sources of protective gas into operation, or by arranging that the hot surface within the enclosure is in a dust-tight or encapsulated housing.

When determining the temperature for rotating electrical machines, the duty type according to IEC 60034-1 as specified by the manufacturer shall also be considered.

7 Safety provisions and safety devices (except for static pressurization)

7.1 General

Protective measures shall be adopted to prevent the electrical apparatus installed in a pressurized enclosure from being energized before pressurization is established. All safety devices shall either be

a) protected by an appropriate type of explosion-protection in accordance with IEC 61241-1-2, or

b) non-electrical and not capable of causing ignition, or

c) located in a non-hazardous area.

The safety devices required by this standard form safety-related parts of a control system. It is the responsibility of the manufacturer and the user to assess that the safety and integrity of the control system is appropriate.

The safety devices shall be provided by the manufacturer of the apparatus or by the user. In the latter case, the apparatus shall be marked "X" and the description documents shall contain all the necessary information required by the user to ensure conformity with the requirements of the standard.

The enclosure shall be cleaned before the electrical supply to the system is connected or restored in order to remove any accumulated combustible dust left in the enclosure, either accidentally following failure of the pressurization system, or following normal shutdown. The manufacturer shall provide the necessary instructions to the user detailing the requirements for cleaning the enclosure.

The manufacturer shall specify the maximum and minimum action levels and tolerances of the safety devices. The safety devices shall be used within the normal operational limits as specified by the manufacturer taking due account of the most onerous conditions specified for normal service.

7.2 Pressure- or flow-activated devices

Pressure-activated devices provided for the operation of alarm and electrical trip devices shall operate when the pressure within the enclosure falls below the permitted minimum value or exceeds the permitted maximum pressure.

Flow-monitoring devices provided for the operation of alarm and electrical trip devices shall operate when the pressure within the enclosure falls below the permitted minimum value, or exceeds the permitted maximum pressure, and shall be located at the outlet.

An electrical interlock on the fan motors or controls is not suitable to indicate failure of pressurization. It does not give an indication in the event of the fan belt slipping, the fan becoming loose on the shaft or reverse rotation of the fan.

7.3 Electrical supply

Where protection is not provided to prevent the ingress of dust following the shutdown or failure of the pressurization system, a warning label shall be fixed stating that dust shall be removed from the interior prior to switching on the electrical supply.

7.4 Switching off electrical supply

When required by this standard, the switching-off of the electrical supply shall require the isolation of all live conductors, including the neutral, in accordance with IEC 61241-1-2.

7.5 Failure of pressurization

The design of a pressurization system relies on the principle that a failure of the pressurization automatically disconnects the system from the electricity supply and/or initiates alarms.

To guard against the possibility that electrical apparatus protected by pressurization may cause an explosion in the case of the protective gas supply failure, the following measures shall be incorporated. They take into account the characteristics of the apparatus, prevailing environmental conditions, and the use of devices for monitoring and warning purposes.

7.5.1 Protection requirements

Requirements applicable to apparatus protected by pressurization vary according to the level of hazard, being dependent on

- the type of apparatus used, and
- the classification of the area, and
- specific installation and process requirements.

These factors require either switching off the electrical supply and giving an alarm, or giving an alarm only.

Whatever protective measures are adopted, the following provisions shall also be made.

a) All electrical apparatus which is to be energized in the absence of pressurization shall be suitable for use in the explosive dust atmosphere corresponding to its position.

b) Visible or audible alarms shall be located where they will immediately be seen or heard by the responsible personnel who will take the necessary action.

c) Either a pressure-monitoring device, flow-monitoring device, or both, shall be used to monitor the satisfactory functioning of the pressurization.

Table 1 – Requirements on failure of pressurization

Area classification	Type of apparatus in the enclosure	
	Ignition-capable apparatus	Apparatus with no sources of ignition in normal operation
Zone 20	Not applicable [a]	Not applicable [a]
Zone 21	7.5.1.1	7.5.1.2
Zone 22	7.5.1.2	Internal pressurization not required

[a] Requirements for ALL apparatus for use in zone 20 have not yet been finalized.

7.5.1.1 Switching off electrical supply

The following requirements apply.

a) An automatic device shall be provided to switch off all electrical supplies to the equipment protected by the apparatus, unless it is protected by one or more of the concepts described in the IEC 61241 series, and initiates an audible and/or visible alarm when the overpressure and/or protective gas flow fall below the minimum prescribed value. In special cases, when the apparatus is intended for use in an installation where the switching-off may jeopardize the safety of the installation or persons, this requirement may be rearranged to provide a continuous audible or visible alarm until pressurization is restored or other appropriate measures are taken.

b) Doors and covers, which can be opened without the use of a tool, shall be interlocked so that, on opening any door or cover, the electrical supplies are switched off from all parts not protected by one or more of the concepts of the IEC 61241 series. This includes all phases and the neutral if available. The supply must be prevented from being switched on again until all doors and covers have been re-closed.

c) A warning shall be prominently mounted on the apparatus stating the following or equivalent:

WARNING: REMOVE ALL DUST FROM THIS ENCLOSURE
BEFORE CONNECTING OR RESTORING THE ELECTRICAL SUPPLY

7.5.1.2 Alarm only

The following requirements apply.

a) An automatic device shall be provided to either audibly and/or visibly warn the operator when the overpressure and/or protective gas flow fall below the minimum prescribed value to enable him to take appropriate measures.

b) All doors and covers which can be opened without the use of a tool shall carry the following warning:

WARNING: DO NOT OPEN WHILE ENERGIZED
UNLESS IT IS OBVIOUS THAT NO COMBUSTIBLE DUST IS PRESENT

c) A warning shall be prominently mounted on the apparatus stating the following or equivalent:

WARNING: REMOVE ALL DUST FROM THE INSIDE OF THE ENCLOSURE
BEFORE CONNECTING OR RESTORING THE ELECTRICAL SUPPLY

7.6 Level of overpressure

A minimum overpressure of 50 Pa (0,5 mbar) shall be maintained relative to the external atmosphere at every point within the enclosure and its associated ducts where leakage can occur.

Examples of the distribution of pressure in different systems of enclosures and ducts are illustrated in figures A.1 and A.2.

NOTE Rotating machines should be of the enclosed type. Consideration should be given in the application of pressurized apparatus having an internally enclosed cooling circuit in which circulation is assisted by an internal fan, since the effect of such fans may be to produce a negative pressure in parts of the casing with consequent risk of ingress of dust if pressurization ceases (see figure A.2).

7.7 Possible sources of ignition

When the protected apparatus incorporates components such as batteries, which remain sources of ignition, suitable precautions shall be taken in the design of the apparatus to prevent the accidental production of sparks, by ensuring that these components are designed with a type of protection appropriate to the characteristics of the prevailing external and internal atmospheres. Such components shall be clearly identified.

7.8 Enclosed components

Any components inside the enclosure which remain in operation in the absence of the protective gas, for example devices for heating the equipment when it is not in operation, shall be protected by one of the types of protection for electrical equipment in combustible dust atmospheres in accordance with IEC 61241-1-2 with the type of protection suitable for the particular hazardous area.

7.9 Separate enclosures

Where the apparatus is intended to form part of a multi-enclosure installation with a common protective gas supply, the resulting design shall take into account the most unfavourable conditions of the whole installation.

If the protective devices are intended to be common, the opening of a door or cover need not necessarily switch off the whole electrical supply or initiate the alarm provided that

a) the opening of a door or cover is preceded by switching off the supplies to the apparatus located in that particular enclosure that is not protected by a suitable concept of dust ignition protection, or the door is interlocked with the supplies to achieve the same end; and

b) the common protective device continues to monitor the rest of the installation.

8 Safety provisions and safety devices for static pressurization

Additional requirements for static pressurization.

The pressurized enclosure shall be filled with an inert gas in a non-hazardous area using the procedure specified by the manufacturer.

Automatic device(s) shall be provided to operate when the overpressure falls below the minimum value specified by the manufacturer. It shall be possible to check the correct operation of the device(s) when the apparatus is in service. The automatic device(s) shall only be capable of being reset by the use of a tool or a key.

NOTE 1 The purpose for which the automatic device(s) is (are) used (i.e. to disconnect power or to sound an alarm or otherwise ensure the safety of the installation) is the responsibility of the user.

The minimum level of overpressure shall be greater than the maximum pressure loss in normal service, measured over a period not less than 100 times the time necessary for the cooling of the enclosed components below the maximum permissible surface temperature for the dust concerned, with a minimum of 1 h. The minimum level of overpressure shall not be less than 50 Pa above the external pressure under the most onerous conditions specified for normal service.

NOTE 2 If the overpressure falls below the minimum specified, it is the user's responsibility to ensure that the pressurized enclosure is removed to a non-hazardous area before refilling.

9 Supply of protective gas

9.1 Type of gas

A protective gas shall be used for maintaining pressurization in the enclosure. The gas shall not, by reason of its chemical characteristics or the impurities that it may contain, reduce the level of protection below that sought, or affect the satisfactory operation and integrity of the apparatus. Means for removing any oil or moisture or other undesirable impurities from the protective gas shall be provided as necessary.

The manufacturer shall specify the protective gas and any alternative permitted.

NOTE 1 The protective gas may also serve other purposes, for example cooling of the apparatus.

NOTE 2 When an inert gas is used, a risk of asphyxiation exists, therefore a suitable warning should be affixed to the enclosure.

9.2 Second source of supply

If a second source of protective gas is required in the event of failure of the primary source, then each source shall be capable of maintaining, independently, the required level of pressure or rate of supply of protective gas.

NOTE This may be advisable where it is necessary to maintain operation of the electrical apparatus.

9.3 Temperature

The temperature of the protective gas shall not normally exceed 40 °C at the inlet of the enclosure. In special circumstances, a higher temperature may be permitted or a lower temperature may be required; in this case, the temperature shall be marked on the enclosure.

NOTE If necessary, measures should be taken to avoid moisture condensation and freezing.

10 Verification and tests

10.1 General

In addition to the type verification and routine tests detailed in IEC 61241-1-1, pressurized enclosures shall be subjected to tests detailed in 10.2 to 10.5 below and, where applicable, 10.6 and 10.7. If applicable, the impact test of 10.6 shall be conducted prior to all other tests.

10.2 Type verification and tests

The following shall be verified either by inspection of the technical documents, or, if necessary, by test.

a) The enclosure design and protection measures are such that pressurization with leakage compensation and pressurization by continuous flow of protective gas are achieved in accordance with this standard.

b) The minimum overpressure (see 7.6) can be maintained with the minimum protective gas supply stated by the manufacturer. For rotating machines, both stationary and rotating conditions shall be tested.

c) Auxiliary devices, such as switches and spark arresters are suitable for the hazardous area.

10.3 Overpressure test

The enclosure and fittings associated with pressurization shall withstand without damage or serious deformation an internal pressure of not less than 1,5 times the maximum pressure specified in normal service or 200 Pa, whichever is the greater. The pressure shall be applied gradually and held for 2 min ± 10 s.

The test is considered to be satisfactory if no permanent deformation occurs which would invalidate the type of protection.

10.4 Minimum overpressure test

10.4.1 Test conditions

The enclosure and associated fittings concerned with pressurization shall be assembled for use and run under normal conditions of operation for 5 min with the minimum protective gas supply as stated by the manufacturer. During and on completion of this period, the minimum overpressure of the enclosure shall be not less than that specified in 7.6.

10.4.2 Number of tests

Enclosures containing apparatus not having moving parts shall be tested once.

Enclosures containing apparatus having moving parts, such as shafts, spindles or other members passing through the wall of the enclosure, which may be moved when the apparatus is in operation, shall be tested both with the apparatus at rest and with the apparatus operating in the manner representative of normal use.

10.5 Leakage test

The pressure in the pressurized enclosure shall be adjusted to the maximum overpressure specified in normal service with a minimum of 200 Pa and, where they are an integral part of the enclosure, the associated ducts and their connecting parts.

The measured flow rate shall be not greater than the maximum leakage flow rate specified by the manufacturer.

In the case of static pressurization, the pressure in the pressurized enclosure shall be adjusted to the maximum overpressure that can occur in normal service. With the aperture(s) closed, the internal pressure shall be monitored for a period of time, according to clause 8. The change of pressure shall not be greater than the minimum overpressure specified in normal service.

10.6 Impact test

An impact test in accordance with IEC 61241-1-1 need only be applied to pressurized enclosures that may be subjected to mechanical damage. Enclosures not subjected to an impact test shall be marked with an "X" and detailed in the test report.

The special conditions for safe use shall be specified in the test report and certificate.

10.7 Routine tests

10.7.1 Overpressure test

The overpressure requirements shall be tested as specified in 10.3.

10.7.2 Leakage test

The maximum leakage flow rate shall be tested as specified in 10.5.

11 Marking

11.1 Pressurized enclosure

The enclosures, except pressurized enclosures protected by static pressurization, shall be marked as follows.

- The name or registered trade mark of the manufacturer.
- Manufacturer's type identification.
- Identification of the type of protection "pD".
- The maximum surface temperature according to clause 6.
- For use in zone 21, the number "21".
- For use in zone 22, the number "22".
- A serial number, if required.
- Any marking normally required by the standards of construction of the electrical apparatus.
- Warning labels, as required by this standard.
- Where a certificate of compliance has been obtained, the name or mark of the national or other appropriate authority and the certificate reference.

11.2 Additional marking

In addition, the following (as agreed upon between the certificate applicant and testing station if necessary).

a) The minimum and, if applicable, maximum pressure during operation, or the minimum rate of flow of protective gas.

b) The type of protective gas (when this is not air).

c) Any other limitations affecting the safe use of the apparatus.

d) The position at which the pressure and flow are monitored shall be indicated either on the equipment enclosure or in the technical manual.

e) For light fittings, the maximum wattage of the lamp which may be used without exceeding the maximum surface temperature of the enclosure.

11.3 Pressurized enclosures protected by static pressurization

A warning label (or labels) shall be fitted with the following wording.

a) THIS ENCLOSURE IS PROTECTED BY STATIC PRESSURIZATION

b) THIS ENCLOSURE SHALL BE FILLED ONLY IN A NON-HAZARDOUS AREA ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS

11.4 Any other marking required

As agreed upon between the certificate applicant and testing station if necessary.

Annex A
(normative)

Ducts for protective gas supply

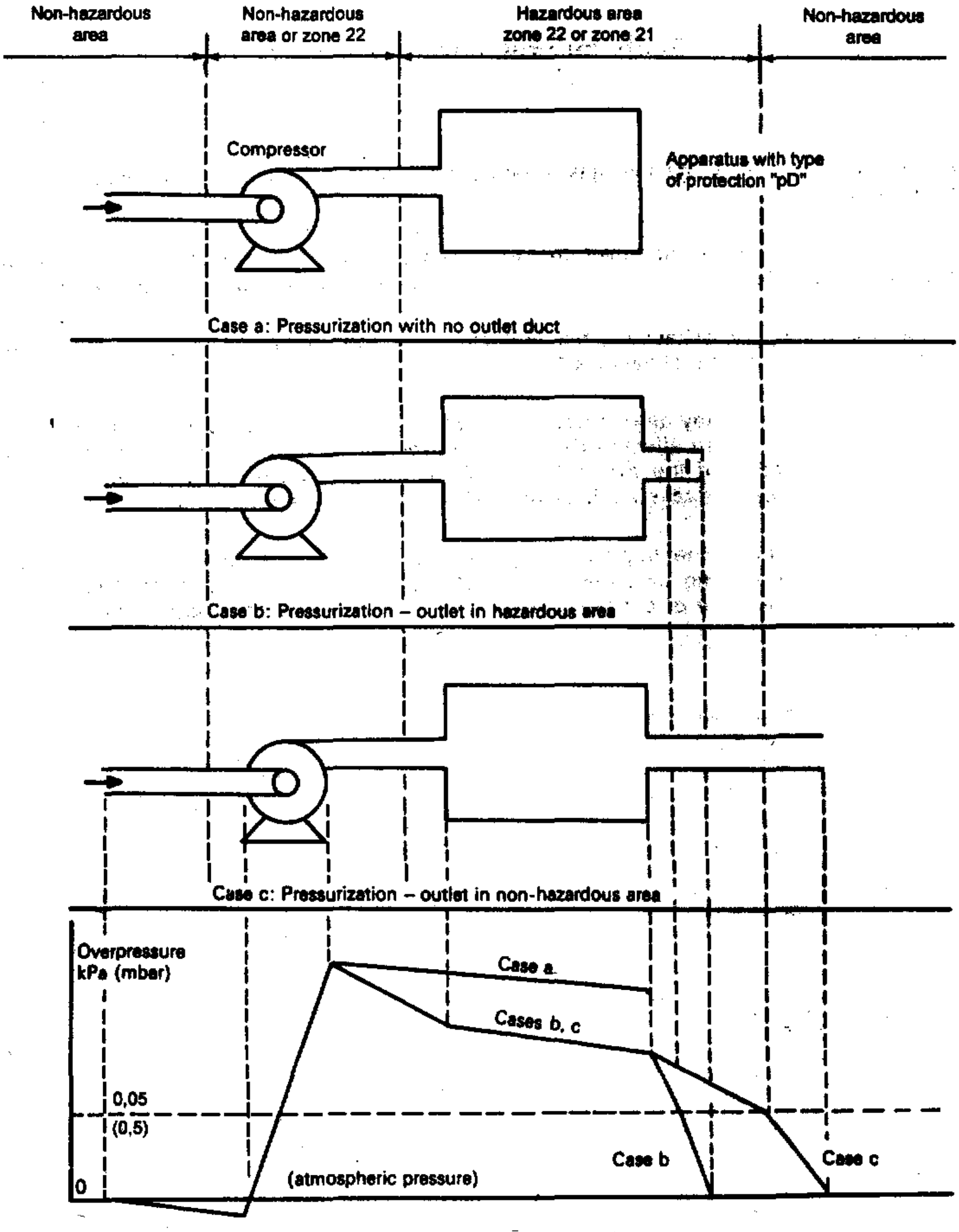
The point at which the protective gas enters the supply duct(s) shall be situated in a non-hazardous area.

The pressurizing equipment and inlet duct to it shall be designed and installed in such a way that leakage of combustible dust into the system cannot occur (see case a of figure A.1).

The duct (or ducts) for exhausting the protective gas shall normally discharge into a non-hazardous area (see case c of figure A.1).

However, the discharge may be in a hazardous area, if the ejection of sparks or incandescent particles is prevented by an effective device (see case b of figure A.1) and if a suitable device stops the rapid suction of the external atmosphere into the enclosure in cases where the temperature of internal surfaces would pose a risk of ignition of combustible dust.

All ducts shall maintain the degree of protection (IP rating) assigned to the pressurized enclosure. The pressurizing equipment and inlet duct to it shall be designed and installed in such a way that leakage of combustible dust into the system cannot occur (see case a of figure A.1).


Non-hazardous area
Non-hazardous area or zone 22
Hazardous area zone 22 or zone 21
Non-hazardous area
Compressor
Apparatus with type of protection "pD"
Case a: Pressurization with no outlet duct
Case b: Pressurization – outlet in hazardous area
Case c: Pressurization – outlet in non-hazardous area
Overpressure kPa (mbar)
Case a
Cases b, c
0,05
(0,5)
0
(atmospheric pressure)
Case b
Case c

Pressure gradients in cases a, b and c

Figure A.1 – Examples of the static overpressure along the ducts and through a pressurized enclosure

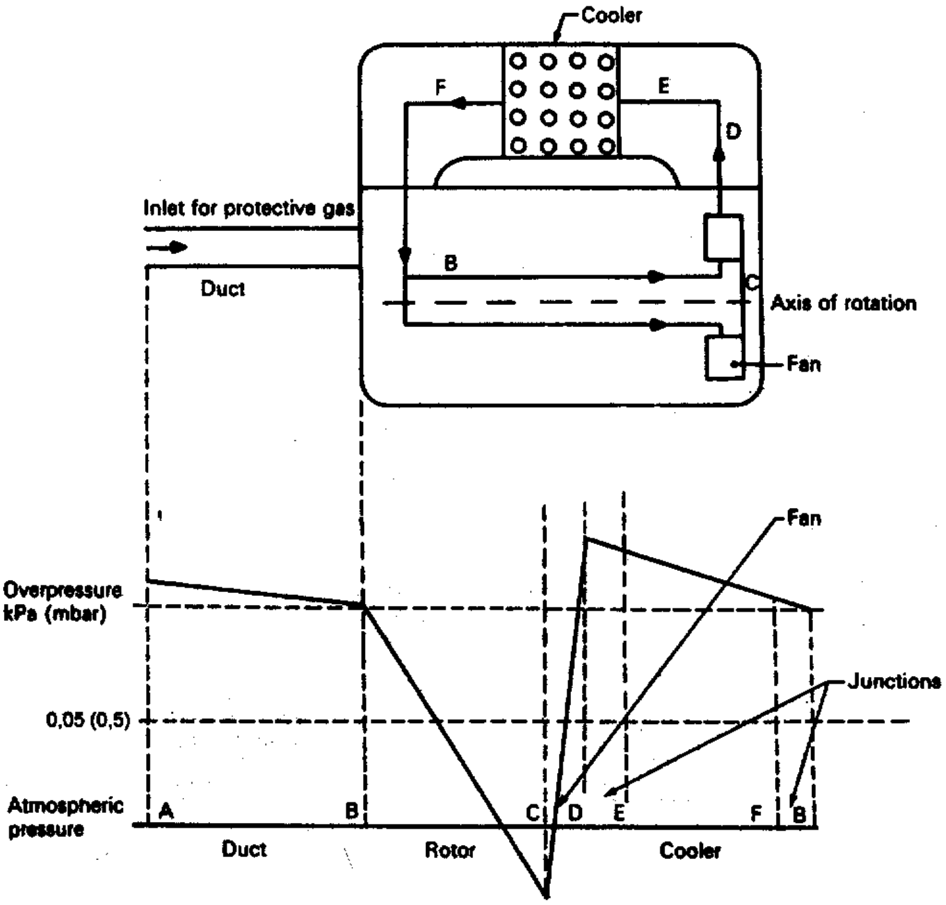


Figure A.2 – Example of the static overpressure in a pressurized electric rotating machine with fan

Annex B
(normative)

Installation requirements for pressurization

These requirements are in addition to those installation requirements given in IEC 61241-1-2.

B.1 Source of protective gas

In certain circumstances, such as where it is necessary to maintain operation of the electrical equipment, it may be advisable to provide two sources of protective gas so that the alternative source may take over in the event of failure of the primary source. Each source shall be capable of maintaining, independently, the required level of pressure or rate of supply of protective gas.

Table B.1 – Summary of protection requirements for enclosures

Area classification	Type of apparatus in the enclosure	
	Ignition-capable apparatus	Apparatus with no sources of ignition in normal operation
Zone 20	Not applicable	Not applicable
Zone 21	Apply B.2	Apply B.3
Zone 22	Apply B.3	Not required

If any of the equipment inside the enclosure is not suitable for a combustible dust atmosphere, upon loss of pressure, the requirements of table B.1 shall be implemented.

B.2 Automatic switch-off

An automatic device shall be provided to switch off the electrical supply to the apparatus and initiate an audible or visible alarm when the overpressure and/or protective gas flow fall below the minimum prescribed value. When such switching-off might jeopardize the safety of the installation and safety is otherwise ensured, a continuous audible or visible alarm shall be provided until pressurization is restored or other appropriate measures are taken including switching off with a known delay.

B.3 Manual switch-off

If the internal pressure or flow of protective gas falls below the minimum prescribed value, a signal which is immediately apparent to the operator shall indicate the loss of pressure. The pressurization system shall be restored as soon as possible, or else the electrical supply shall be switched off manually.

B.4 Common supply of protective gas

When a source of protective gas is common to separate enclosures, the protective measures may be common to several, provided that the resulting protection takes account of the most unfavourable conditions in the whole assembly.

If the protective devices are common, the opening of a door or cover need not switch off the electrical supply to the whole assembly or initiate the alarm provided that

a) the said opening is preceded by switching off the electrical supply to that particular equipment, except to such parts as are protected by a suitable type of protection;
b) the common protective device continues to monitor the pressure in all the other enclosures of the group; and
c) the subsequent switching-on of the electrical supply to that particular equipment is preceded by the applicable cleaning procedure.

B.5 Switching off electrical supply

a) Before switching on the electrical supply to the apparatus on start-up or after shutdown, it is the responsibility of the operator to be satisfied that dust has not penetrated the enclosure or associated ducts in such concentration that is likely to create a potential dust hazard. The operator shall take into account in making such an assessment:
    1) the need for a substantial safety margin; and
    2) the level of concentration in air of the applicable explosive dust required for a hazard to exist; and, if applicable,
    3) the thickness of dust layers where there is a potential for combustion to occur due to heating.

c) Doors and covers, which can be opened without the use of tools, shall be interlocked so that automatically on opening the electrical supply is switched off from all parts not otherwise protected. The supply must be prevented from being switched on again until the doors and covers have been re-closed.

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(Continued from second cover)

Only the English language text has been retained while adopting it as an Indian Standard, and as such the page numbers given here are not the same as in the IEC Standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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